C & EE 141

Composite Beam Design
Part 3

Composite Beam Design Tables

Tables 3-19 & 3-20

Table 3-19 (continued)
Composite W-Shapes
Available Strength in Flexure, kip-ft

W30-W27

F_y = 50 ksi

Shape	M_p/Ω_b	$\phi_b M_p$	PNA[c]	$Y1$[a]	ΣQ_n	$Y2$[b], in.							
	kip-ft					2		2.5		3		3.5	
	ASD	LRFD		in.	kip	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
W30×108	863	1300	TFL	0	1590	1340	2010	1380	2070	1420	2130	1460	2190
			2	0.190	1390	1320	1980	1350	2030	1380	2080	1420	2130
			3	0.380	1190	1290	1940	1320	1990	1350	2030	1380	2080
			4	0.570	987	1270	1910	1290	1940	1320	1980	1340	2020
			BFL	0.760	787	1240	1870	1260	1900	1280	1930	1300	1960
			6	4.04	592	1200	1800	1210	1830	1230	1850	1240	1870
			7	7.63	396	1120	1690	1130	1700	1140	1720	1150	1730
W30×99	778	1170	TFL	0	1450	1220	1830	1260	1890	1290	1940	1330	[illegible]
			2	0.168	1270	1200	1800	1230	1850	1260	1900	1300	1950
			[illegible]	0.335	1100	[illegible]	[illegible]	1210	[illegible]	[illegible]	1860	1260	1900
			4	0.503	922	1160	1740	1180	1780	1210	1810	1230	1850
			BFL	0.670	747	1140	1710	1160	1740	1170	1770	1190	1790
			6	4.19	555	1100	1650	1110	1670	1120	1690	1140	1710
			7	7.88	363	1020	1530	1030	1540	1040	1560	1050	1570
W30×90	706	1060	TFL	0	1320	1100	1650	1130	1700	1160	1750	1200	1800
			2	0.153	1160	1080	1630	1110	1670	1140	1710	1170	1760
			3	0.305	998	1070	1600	1090	1640	1110	1680	1140	1710
			4	0.458	839	1050	1570	1070	1600	1090	1640	1110	1670
			BFL	0.610	681	1030	1540	1040	1570	1060	1590	1080	1620
			6	4.01	505	989	1490	1000	1510	1010	1530	1030	1540
			7	7.76	329	920	1380	928	1400	937	1410	945	1420
W27×102	761	1140	TFL	0	1500	1160	1750	1200	1810	1240	1860	1280	1920
			2	0.208	1290	1140	1720	1170	1770	1210	1810	1240	1860
			3	0.415	1090	1120	1680	1150	1720	1170	1760	1200	1800
			4	0.623	878	1090	1640	1110	1670	1140	1710	1160	1740
			BFL	0.830	670	1060	1600	1080	1620	1100	1650	1110	1670
			6	3.40	523	1030	1550	1050	1570	1060	1590	1070	1610
			7	6.27	375	984	1480	993	1490	1000	1510	1010	1520
W27×94	694	1040	TFL	0	1380	1060	1600	1100	1650	1130	1700	1170	1750
			2	0.186	1190	1040	1570	1070	1610	1100	1660	1130	1700
			3	0.373	1010	1020	1540	1050	1580	1070	1610	1100	1650
			4	0.559	821	1000	1500	1020	1530	1040	1570	1060	1600
			BFL	0.745	635	976	1470	992	1490	1010	1510	1020	1540
			6	3.45	490	947	1420	959	1440	971	1460	983	1480
			7	6.41	345	897	1350	905	1360	914	1370	922	1390

ASD	LRFD
$\Omega_b = 1.67$	$\phi_b = 0.90$

[a] $Y1$ = distance from top of the steel beam to plastic neutral axis
[b] $Y2$ = distance from top of the steel beam to concrete flange force
[c] See Figure 3-3c for PNA locations.

Table 3-19 (continued)
Composite W-Shapes
Available Strength in Flexure, kip-ft

F_y = 50 ksi

W30-W27

Shape	$Y2$[b], in.													
	4		4.5		5		5.5		6		6.5		7	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
W30×108	1490	2250	1530	2310	1570	2370	1610	2430	1650	2480	1690	2540	1730	2600
	1450	2190	1490	2240	1520	2290	1560	2340	1590	2390	1630	2450	1660	2500
	1410	2120	1440	2170	1470	2210	1500	2260	1530	2300	1560	2340	1590	2390
	1370	2050	1390	2090	1420	2130	1440	2170	1470	2200	1490	2240	1510	2280
	1320	1980	1340	2010	1360	2040	1380	2070	1400	2100	1420	2130	1440	2160
	1260	1890	1270	1910	1290	1940	1300	1960	1320	1980	1330	2000	1350	2030
	1160	1750	1170	1760	1180	1780	1190	1790	1200	1810	1210	1820	1220	1840
W30×99	1360	2050	1400	2100	1440	2160	1470	2210	1510	2270	1540	2320	1580	2380
	1330	2000	1360	2040	1390	2090	1420	2140	1460	2190	1490	2230	1520	2280
	1290	[illegible]	[illegible]	1980	[illegible]	[illegible]	1370	[illegible]	[illegible]	2100	[illegible]	[illegible]	1460	[illegible]
	1250	1880	1270	1920	1300	1950	1320	1990	1340	2020	1370	2050	1390	2090
	1210	1820	1230	1850	1250	1880	1270	1910	1290	1930	1300	1960	1320	1990
	1150	1730	1160	1750	1180	1770	1190	1790	1210	1810	1220	1830	1230	1850
	1050	1590	1060	1600	1070	1610	1080	1630	1090	1640	1100	1650	1110	1670
W30×90	1230	1850	1260	1900	1300	1950	1330	2000	1360	2050	1390	2100	1430	2150
	1200	1800	1230	1840	1260	1890	1280	1930	1310	1970	1340	2020	1370	2060
	1160	1750	1190	1790	1210	1830	1240	1860	1260	1900	1290	1940	1310	1970
	1130	1700	1150	1730	1170	1760	1190	1790	1210	1820	1230	1860	1260	1890
	1090	1640	1110	1670	1130	1700	1150	1720	1160	1750	1180	1770	1200	1800
	1040	1560	1050	1580	1070	1600	1080	1620	1090	1640	1100	1660	1120	1680
	953	1430	961	1440	969	1460	978	1470	986	1480	994	1490	1000	1510
W27×102	1310	1970	1350	2030	1390	2090	1430	2140	1460	2200	1500	2260	1540	2310
	1270	1910	1300	1960	1340	2010	1370	2060	1400	2100	1430	2150	1460	2200
	1230	1840	1250	1880	1280	1930	1310	1970	1340	2010	1360	2050	1390	2090
	1180	1770	1200	1810	1220	1840	1250	1870	1270	1900	1290	1940	1310	1970
	1130	1700	1150	1720	1160	1750	1180	1770	1200	1800	1210	1830	1230	1850
	1090	1630	1100	1650	1110	1670	1130	1690	1140	1710	1150	1730	1160	1750
	1020	1540	1030	1550	1040	1560	1050	1580	1060	1590	1070	1610	1080	1620
W27×94	1200	1810	1240	1860	1270	1910	1300	1960	1340	2010	1370	2060	1410	2120
	1160	1750	1190	1790	1220	1840	1250	1880	1280	1930	1310	1970	1340	2020
	1120	1690	1150	1730	1170	1760	1200	1800	1220	1840	1250	1880	1270	1920
	1080	1630	1110	1660	1120	1690	1140	1720	1160	1750	1180	1780	1210	1810
	1040	1560	1050	1590	1070	1610	1090	1630	1100	1660	1120	1680	1130	1700
	996	1500	1010	1510	1020	1530	1030	1550	1040	1570	1060	1590	1070	1610
	931	1400	940	1410	948	1430	957	1440	965	1450	974	1460	983	1480

ASD	LRFD
$\Omega_b = 1.67$	$\phi_b = 0.90$

[a] $Y1$ = distance from top of the steel beam to plastic neutral axis
[b] $Y2$ = distance from top of the steel beam to concrete flange force
[c] See Figure 3-3c for PNA locations.

LEFT SIDE OF THE PAGE

Table 3-19 (continued)
Composite W-Shapes
Available Strength in Flexure, kip-ft

W30-W27

F_y = 50 ksi

Shape	M_p/Ω_b	$\phi_b M_p$	PNA[c]	$Y1$[a]	ΣQ_n	$Y2$[b], in.							
	kip-ft					2		2.5		3		3.5	
	ASD	LRFD		in.	kip	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
W30×108	863	1300	TFL	0	1590	1340	2010	1380	2070	1420	2130	1460	2190
			2	0.190	1390	1320	1980	1350	2030	1380	2080	1420	2130
			3	0.380	1190	1290	1940	1320	1990	1350	2030	1380	2080
			4	0.570	987	1270	1910	1290	1940	1320	1980	1340	2020
			BFL	0.760	787	1240	1870	1260	1900	1280	1930	1300	1960
			6	4.04	592	1200	1800	1210	1830	1230	1850	1240	1870
			7	7.63	396	1120	1690	1130	1700	1140	1720	1150	1730
W30×99	778	1170	TFL	0	1450	1220	1830	1260	1890	1290	1940	1330	2000
			2	0.168	1270	1200	1800	1230	1850	1260	1900	1300	1950
			3	0.335	1100	1180	1780	1210	1820	1240	1860	1260	1900

ASD	LRFD
$\Omega_b = 1.67$	$\phi_b = 0.90$

[a] $Y1$ = distance from top of the steel beam to plastic neutral axis
[b] $Y2$ = distance from top of the steel beam to concrete flange force
[c] See Figure 3-3c for PNA locations.

RIGHT SIDE OF THE PAGE

F_y = 50 ksi

Table 3-19 (continued)
Composite W-Shapes
Available Strength in Flexure, kip-ft

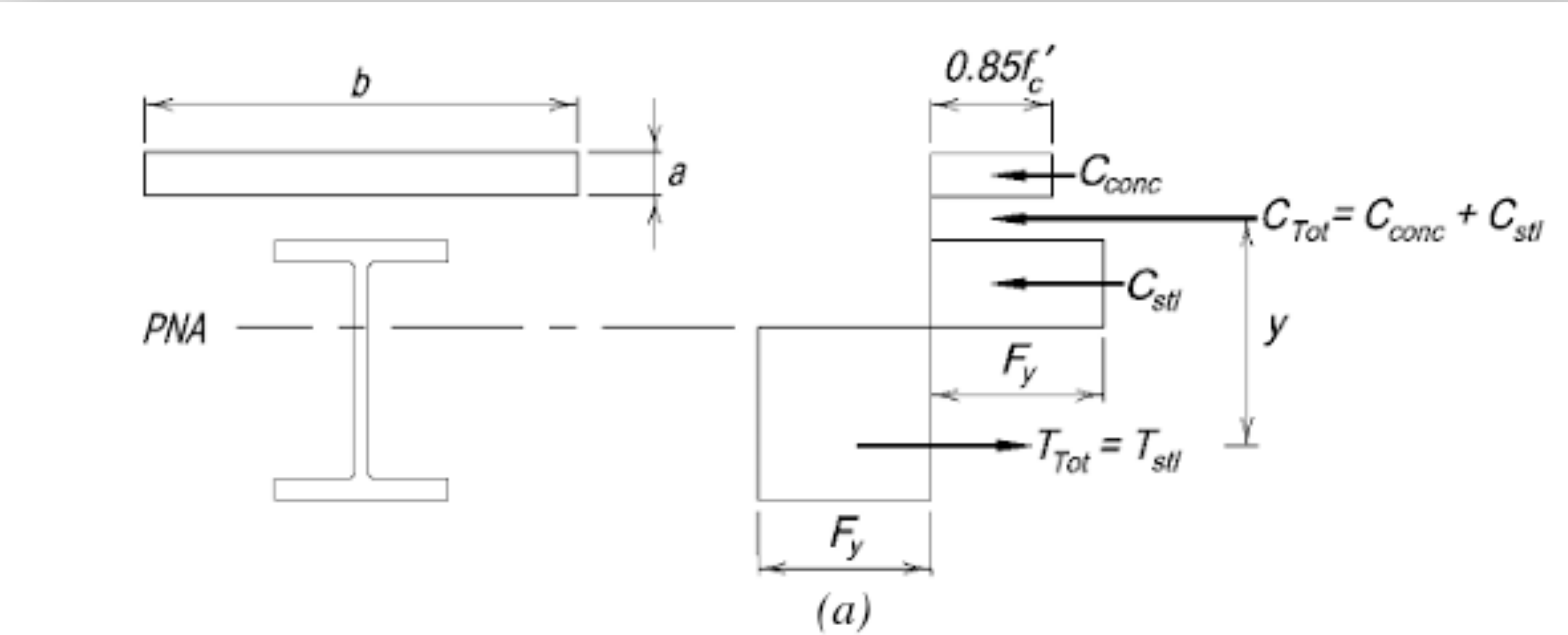
W30-W27

Shape	$Y2^b$, in.													
	4		4.5		5		5.5		6		6.5		7	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
W30×108	1490	2250	1530	2310	1570	2370	1610	2430	1650	2480	1690	2540	1730	2600
	1450	2190	1490	2240	1520	2290	1560	2340	1590	2390	1630	2450	1660	2500
	1410	2120	1440	2170	1470	2210	1500	2260	1530	2300	1560	2340	1590	2390
	1370	2050	1390	2090	1420	2130	1440	2170	1470	2200	1490	2240	1510	2280
	1320	1980	1340	2010	1360	2040	1380	2070	1400	2100	1420	2130	1440	2160
	1260	1890	1270	1910	1290	1940	1300	1960	1320	1980	1330	2000	1350	2030
	1160	1750	1170	1760	1180	1780	1190	1790	1200	1810	1210	1820	1220	1840
W30×99	1360	2050	1400	2100	1440	2160	1470	2210	1510	2270	1540	2320	1580	2380
	1330	2000	1360	2040	1390	2090	1420	2140	1460	2190	1490	2230	1520	2280
	1290	1940	1320	1980	1350	2020	1370	2060	1400	2100	1430	2150	1460	2190

ASD	LRFD
$\Omega_b = 1.67$	$\phi_b = 0.90$

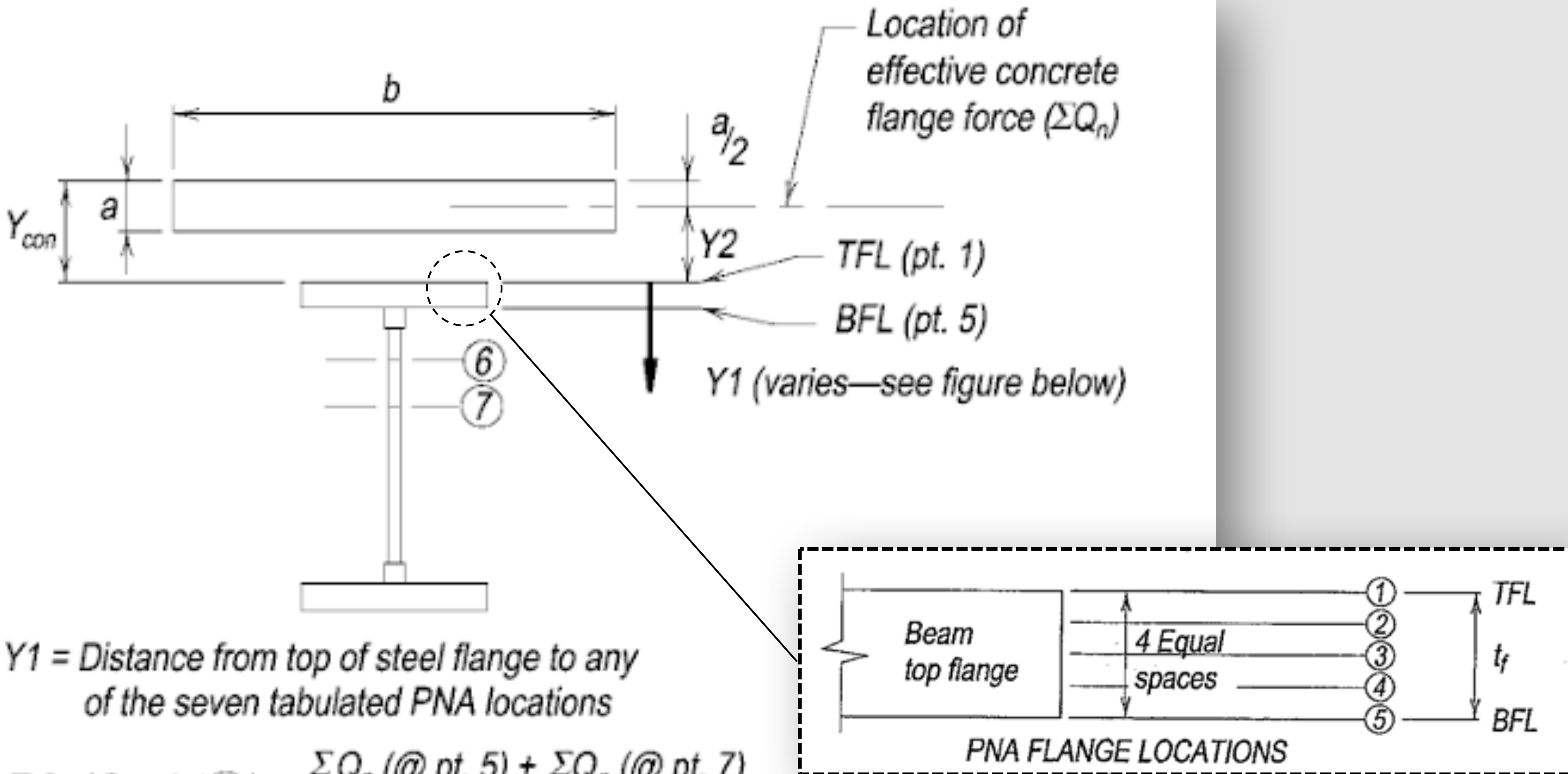
[a] $Y1$ = distance from top of the steel beam to plastic neutral axis
[b] $Y2$ = distance from top of the steel beam to concrete flange force
[c] See Figure 3-3c for PNA locations.

Composite Beam Tables



- Created for a generic case where the PNA could be in the concrete or the steel beam

Composite Beam Tables



Y1 = Distance from top of steel flange to any of the seven tabulated PNA locations

$$\Sigma Q_n \text{ (@ point 6)} = \frac{\Sigma Q_n \text{ (@ pt. 5)} + \Sigma Q_n \text{ (@ pt. 7)}}{2}$$

$$\Sigma Q_n \text{ (@ point 7)} = 0.25 F_y A_s$$

Table 3-20 (continued)

Lower-Bound Elastic Moment of Inertia, I_{LB}, for Plastic Composite Sections

F_y = 50 ksi

I_{LB}

W30-W27

Shape[d]	PNA[c]	$Y1$[a]	$\sum Q_n$	$Y2$[b], in.										
		in.	kip	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7
W30×108	TFL	0	1590	9000	9280	9560	9840	10100	10400	10800	11100	11400	11700	12100
(4470)	2	0.190	1390	8700	8950	9220	9480	9760	10000	10300	10600	10900	11300	11600
	3	0.380	1190	8350	8590	8830	9070	9330	9590	9850	10100	10400	10700	11000
	4	0.570	987	7940	8150	8370	8590	8820	9050	9290	9530	9780	10000	10300
	BFL	0.760	787	7470	7650	7840	8030	8230	8430	8640	8850	9060	9290	9510
	6	4.04	592	6930	7080	7230	7390	7550	7710	7880	8060	8240	8420	8600
	7	7.63	396	6280	6390	6500	6620	6730	6850	6980	7110	7240	7370	7510
W30×99	TFL	0	1450	8110	8350	8610	8870	9140	9420	9700	9990	10300	10600	10900
(3990)	2	0.168	1270	7830	8070	8300	8550	8800	9060	9330	9600	9880	10200	105[illegible]
	3	0.335	1100	7540	7760	7980	8200	8440	8670	8920	9170	9430	9690	9960
	4	0.503	922	7190	7380	7580	7790	8000	8210	8430	8660	8890	9130	9370
	BFL	0.670	747	6790	6960	7130	7310	7490	7680	7880	8070	8280	8480	8700
	6	4.19	555	6270	6410	6550	6690	6840	7000	7150	7310	7480	7650	7820
	7	7.88	363	5640	5740	5840	5950	6050	6160	6280	6390	6510	6640	6760
W30×90	TFL	0	1320	7310	7530	7760	8000	8240	8490	8750	9010	9280	9560	9840
(3610)	2	0.153	1160	7070	7280	7490	7720	7940	8180	8420	8660	8920	9180	9440
	3	0.305	998	6790	6990	7190	7390	7600	7820	8040	8260	8500	8730	8980
	4	0.458	839	6480	6660	6840	7020	7210	7410	7610	7810	8020	8240	8460
	BFL	0.610	681	6130	6280	6440	6600	6760	6940	7110	7290	7470	7660	7850
	6	4.01	505	5660	5780	5910	6040	6180	6310	6460	6600	6750	6910	7060
	7	7.76	329	5090	5180	5270	5360	5460	5560	5660	5770	5880	5990	6100
W27×102	TFL	0	1500	7250	7480	7730	7980	8240	8510	8780	9060	9350	9650	9950
(3620)	2	0.208	1290	6970	7190	7420	7650	7890	8140	8390	8650	8920	9200	9480
	3	0.415	1090	6670	6870	7080	7290	7510	7730	7960	8200	8450	8700	8950
	4	0.623	878	6300	6470	6650	6840	7030	7230	7430	7640	7850	8070	8300
	BFL	0.830	670	5860	6010	6160	6310	6470	6640	6810	6980	7160	7340	7530
	6	3.40	523	5500	5620	5740	5870	6010	6150	6290	6430	6580	6740	6900
	7	6.27	375	5070	5170	5260	5360	5470	5570	5680	5800	5910	6030	6150
W27×94	TFL	0	1380	6560	6780	7000	7230	7470	7720	7970	8230	8490	8760	9040
(3270)	2	0.186	1190	6320	6520	6730	6940	7160	7390	7620	7860	8100	8360	8610
	3	0.373	1010	6050	6240	6430	6620	6820	7030	7240	7460	7680	7910	8150
	4	0.559	821	5730	5890	6060	6230	6400	6590	6770	6970	7160	7370	7580
	BFL	0.745	635	5350	5480	5620	5770	5920	6070	6230	6390	6560	6730	6910
	6	3.45	490	5000	5110	5230	5350	5470	5600	5730	5870	6010	6150	6290
	7	6.41	345	4590	4670	4760	4860	4950	5050	5150	5250	5360	5470	5580

[a] $Y1$ = distance from top of the steel beam to plastic neutral axis
[b] $Y2$ = distance from top of the steel beam to concrete flange force
[c] See Figure 3-3c for PNA locations.
[d] Value in parentheses is I_x (in.[4]) of noncomposite steel shape.

Composite Elastic Moment of Inertia

- Use to calculate post-composite deflection under service level loads

F_y = 50 ksi

Table 3-20 (continued)
Lower-Bound Elastic Moment of Inertia, I_{LB}, for Plastic Composite Sections

I_{LB}

W30-W27

Shape[d]	PNA[c]	$Y1$[a]	$\sum Q_n$	$Y2$[b], in.										
		in.	kip	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7
W30×108	TFL	0	1590	9000	9280	9560	9840	10100	10400	10800	11100	11400	11700	12100
(4470)	2	0.190	1390	8700	8950	9220	9480	9760	10000	10300	10600	10900	11300	11600
	3	0.380	1190	8350	8590	8830	9070	9330	9590	9850	10100	10400	10700	11000
	4	0.570	987	7940	8150	8370	8590	8820	9050	9290	9530	9780	10000	10300
	BFL	0.760	787	7470	7650	7840	8030	8230	8430	8640	8850	9060	9290	9510
	6	4.04	592	6930	7080	7230	7390	7550	7710	7880	8060	8240	8420	8600
	7	7.63	396	6280	6390	6500	6620	6730	6850	6980	7110	7240	7370	7510
W30×99	TFL	0	1450	8110	8350	8610	8870	9140	9420	9700	9990	10300	10600	10900
(3990)	2	0.168	1270	7830	8070	8300	8550	8800	9060	9330	9600	9880	10200	10500
	3	0.335	1100	7540	7760	7980	8200	8440	8670	8920	9170	9430	9690	9960

[a] $Y1$ = distance from top of the steel beam to plastic neutral axis
[b] $Y2$ = distance from top of the steel beam to concrete flange force
[c] See Figure 3-3c for PNA locations.
[d] Value in parentheses is I_x (in.^{4}) of noncomposite steel shape.

Design Procedure Using Tables

- Determine b_e
- Assume ΣQ_n
  - 1 stud/ft usually reasonable
- Calculate Y2
- Select beam w/ sufficient strength at ΣQ_n and Y2
- If beam too large, try increasing ΣQ_n and revising selection
- Calculate N studs for ΣQ_n
- Verify N studs can be placed observing stud detailing requirements.
- Check total deflections
- Adjust ΣQ_n or beam selection as required to satisfy deflection.
- Check beam for pre-composite loads and deflections, iterate as necessary.

Questions

EXAMPLE PROBLEMS